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# LOCAL SECONDARY EFFECTS OF WATERSHED PROJECTS

## A CASE STUDY OF ROGER MILLS COUNTY, OKLAHOMA

ERS 178

RESOURCE DEVELOPMENT ECONOMICS DIVISION•ECONOMIC RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE IN COOPERATION WITH DEPARTMENT OF
AGRICULTURAL ECONOMICS•OKLAHOMA AGRICULTURAL EXPERIMENT STATION

# PREFACE

This publication presents results of one phase of a program of economic investigations on upstream watershed development in the Washita River Basin of Oklahoma. The program is a cooperative undertaking between the Economic Research Service, U. S. Department of Agriculture, and the Department of Agricultural Economics, Oklahoma Agricultural Experiment Station. This study of the Washita River Basin is part of a larger program of investigations of Watershed Protection and Flood Prevention being carried out through an agreement between the Economic Research Service and the Soil Conservation Service.

The assistance of local leaders in Roger Mills County was required for carrying out this study. In particular, essential information was provided by Mr. L. L. Males, President of the Security State Bank at Cheyenne, Oklahoma, and by Mr. Charlie A. Burns, County Agricultural Agent of Roger Mills County.

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# SUMMARY

Local economic benefits of watershed projects arise from two major sources: (1) net primary income, or increases in net incomes of the direct recipients of products and services from the projects, and (2) net secondary income, or increases in net incomes of other local people through multiplier effects of the primary income. Local primary income has been estimated by the Soil Conservation Service in the process of project planning. Practical methods for making reliable estimates of local secondary income in the planning process are yet to be developed. This study represents an initial step in research to devise these methods. Emphasis in the study is on increasing understanding of the economic processes which generate local secondary income and on estimating ratios of secondary to primary income for one local area.

This study was conducted in Roger Mills County, Okla., where 90 of the 130 planned structures for upstream flood protection were complete by January 1963.

For purposes of this study, net primary and net secondary incomes from watershed projects were expressed in terms of disposable income to recipients. The study excluded estimation of primary benefits, which were unnecessary for ascertaining the ratios of secondary to primary income. Instead, the procedure was to determine the interdependent relations among sectors of the local economy; then, the income ratios could be estimated directly. The indirect effects of agricultural and of recreational income from the projects in Roger Mills County were compared.

For each assumed $100,000 increase in gross receipts to farmers in the County, there was an estimated net (disposable) income to farmers of $26,867. On the average, each $100,000 of gross receipts to farmers generated $77,845 in gross receipts to other sectors of the local economy and a net income of $16,457 to these sectors. Thus, the local gross-receipts multiplier of farm income was 1.78, and the local net-income multiplier was 1.62. According to these estimates, farmers would receive 62 percent of the increases in total local net income from projects built exclusively for agricultural purposes.

Recreational expenditures in the County by nonresident users of the lakes were estimated in a separate study. Net income to the County from these gross receipts was only about half the net income accruing from comparable increases in gross receipts from farming. Also, farmers received only about 2 percent of the net income to the County from recreation.

The results of this study can be applied only to other local areas with economic characteristics similar to those of Roger Mills County. Additional research is needed to ascertain how local multipliers change with changes in characteristics of local economies.

# LOCAL SECONDARY EFFECTS OF WATERSHED PROJECTS:
## A Case Study of Roger Mills County, Oklahoma

by

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## INTRODUCTION

Watershed projects for upstream flood control and soil erosion prevention were first authorized by the Flood Control Act of 1944. Eleven river basins were designated for this development. The Soil Conservation Service of the U.S. Department of Agriculture was given responsibility for administering the development of these basins. The Washita River Basin of Oklahoma and Texas was one of the 11 designated basins. This basin contains 6,500 square miles of land area, and over 90 percent of this area lies within the State of Oklahoma. As of January 1963, 524 of the 915 floodwater-retarding structures (dams) planned for the basin were either contracted for or completed. 1/ Although the major purposes of the structures were flood prevention and erosion control, other direct benefits from them included supplemental irrigation, water supply for livestock, and recreation.

Generally, in estimating the benefits of the projects, the Soil Conservation Service includes only the primary income, or the anticipated value of goods and services produced by the projects. It is well known that the total economic impacts of resource development in local areas exceed the value of goods and services produced by the projects. The various sectors of a local economy contain a degree of interdependence whereby an increase in income to one sector results, indirectly, in some increase in income to other sectors. Thus, there is a local multiplier effect of direct benefits from the projects, and the size of this multiplier expresses the local secondary or indirect income per dollar of direct income from the projects. 2/ Because the sectors

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1/ Soil Conservation Service. Progress Report presented at the Annual Meeting of the Washita Council, Stillwater, Okla. U.S. Dept. Agr., Jan. 1963 (mimeo.)

2/ The concept of secondary benefits employed in this report differs from that in the Report to the Inter-Agency Committee on Water Resources, Proposed Practices for Economic Analysis of River Basin Projects, prepared by the Subcommittee on Evaluation Standards, May 1958. This Report defines secondary benefits as those values added to the national economy over and above primary benefits. Two types of secondary benefits are identified: (1) "stemming from" effects, or increases in net incomes through processing the increased volume of production attributable to the project, and (2) "induced by" effects, or all other attributable secondary benefits. As we use them, the terms "stemming from" and "induced by" effects are limited to those effects applicable to a specified local area, and to those actually affecting monetary receipts, expenditures, and net incomes.

of a local economy differ in patterns of local and nonlocal expenditures, the local multiplier will not be the same for all sources of direct income from watershed projects. Also, local economies differ in economic characteristics. Therefore, local multipliers can be expected to vary in magnitude.

The major purpose of this study was to estimate the local multiplier effects of farm income for one county affected significantly by the Washita River Basin development program. A subsidiary objective was to estimate, for purposes of comparison, the local multiplier effects of recreational income in the same county. Roger Mills County, located on the western border of Oklahoma, was selected for the study because (1) about 75 percent of its land area was within the Washita River Basin, (2) the project was near completion in this County (90 of the 130 planned structures were complete by January 1963), (3) the economic base of the County was mainly agricultural, and (4) substantial recreational activity had developed by 1960 as a result of the floodwater-retarding reservoirs. The study excluded an investigation of the primary income from the watershed projects in the County. Estimates of primary recreational income arising from the upstream reservoirs were made in a separate study. 3/

Since the primary project benefits were not estimated, this study excluded estimation of total dollar volume of primary and secondary income to the County from the projects. The purpose was restricted to estimating a ratio of local secondary to primary benefits. From this ratio, the total local economic impacts can be estimated for any given amount and kind of monetary primary benefits. 4/

Economic consequences of the projects on areas outside the County are not considered in this study. Thus, the results of this evaluation cannot be taken as a basis for estimating national effects of watershed development. There is, however, a relationship between national income associated with farmer expenditures and local multipliers as conceived for this study. (See appendix A.)

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3/ Burns, Charlie A., and Back, W. B. Recreational Possibilities of Upstream Reservoirs. Okla. Current Farm Econ. 36: p. 8, 1963.

4/ Dynamic secondary effects of the projects, such as location of new industries in the areas or changes to more efficient combination of resources or of products, are possible, but will not be taken into account by the multiplier as used in this study. Such dynamic or "triggered" effects of the projects are unpredictable for any given local area.

## PROCEDURES IN OBTAINING AND DEVELOPING THE DATA

The estimation of local (County) multiplier effects for various kinds of primary income required the selection of a scheme for expressing the monetary transactions of each sector of the local economy. This scheme permitted the use of mathematical techniques for determining the interdependent relations among the local sectors and between each local sector and the nonlocal economy. In order to conform with the predetermined mathematical specifications, the procedures in this study (other than the mathematical computations used in analyzing the data) encompassed the following:

(1) Development of a classification of households of Roger Mills County by economic sectors;

(2) Estimation of monetary flows among these local sectors, and between each of these sectors and those outside the County's economy; and

(3) Classification of the monetary transactions in accordance with the accounting scheme selected for the study.

### Classification of the Households

After experimenting with various classification schemes, we selected one that aggregated all households of the County into 11 economic sectors (table 1). The nonlocal economy was treated as the 12th sector. The classification system used by the U.S. Census of Business was a general guide in grouping the households into economic sectors; however, final selection of a system was based mainly upon the manageability of a scheme and its consistency with the purposes of this study.

Except for the full-time farm laborers living on farms, the agricultural sector A consisted of farm-operator families. This was the largest sector in the County. Sector B included two classes of households: (1) those with major source of income from wages received, and (2) those with major source of income from social security, welfare, pensions, or other sources not associated with labor, land, or capital income. The government workers (sector C) included those residing in the County whose major source of income was the County or nonlocal government. The other local sectors were the retail business establishments, farm markets, processing businesses, and professional, personal, and social services. The outside sector (N) was included in order to identify exports from and imports to the County.

The development of this classification of households required compilation of a directory of all households in the County. This directory was developed by a committee of local public and private leaders which helped place each household in one of the economic sectors according to major source of receipts (income). In all, there were 1,758 households in the directory. Of this total, about 63 percent were farm households. This directory applied to residents of the County as of 1960.

Table 1.-- Classification of households (economic units) into economic sectors, Roger Mills County, Okla.

| Sector | Type of economic unit | Estimated number of households: In County | Estimated number of households: In sample 1/ |
|---|---|---|---|
| A | Farmers, ranchers, and full-time farm laborers living on farms | 1,112 | 550 |
| B | Wage earners, welfare, social security, pension recipients (includes all nongovernment workers, those not owning or operating a business or profession, or those not farming) | 312 | 213 |
| C | Government workers (includes all employees of the County, and nonlocal government workers who reside in the County) | 146 | 105 |
| D | Eating and drinking establishments (includes cafes, grocery stores, taverns, and general stores) | 40 | 31 |
| E | Department, drug, jewelry, and variety stores | 18 | 15 |
| F | Automobile and farm equipment retail establishments, service stations, garages, and blacksmith shops | 36 | 26 |
| G | Lumber yards, hardware, utilities, and construction companies | 19 | 12 |
| H | Elevators, feed and produce stores, livestock auctions, trucking companies, and custom work | 21 | 15 |
| I | Personal services--beauty and barber shops, cleaners, hotels and motels, and movie theaters | 22 | 18 |
| J | Professional services--insurance agents, lawyers, doctors, abstracters, and proprietors of hospitals, and funeral home, bank, and publishing companies | 21 | 17 |
| K | Social services--churches, ministers, and social and civic organizations | 11 | 7 |
| N | Nonlocal--exports and imports | -- | -- |
|  | Total households | 1,758 | 1,009 |

1/ The households in the sample include only those that were clients of the bank from which a sample of microfilmed copies of checks was taken.

## Source of Data and Sampling Procedure

Arrangements were made with a local banker to obtain information available from a sample of microfilmed copies of checks which had cleared his bank in 1960. This was the only bank in Cheyenne (the County Seat) and the only bank centrally located in the County. It accounted for about two-thirds of the financial transactions in the various sectors (table 1).

A sample scheme was designed to provide a "composite month" of 24 days from the universe of 306 banking days available in 1960 (table 2). The criteria for selecting the sample days were as follows: (1) 2 days were to be selected for each month, (2) 4 days were to be selected for each day of the week, and (3) half of the sample days were to be from the first part of each month, and the other half from the last part of each month.

Table 2.--Banking days of 1960 included in the sample of checks from the Cheyenne bank

| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|
| June 20 | Nov. 1 | Feb. 17 | Aug. 11 | Mar. 4 | Aug. 27 |
| Jan. 25 | May 24 | Apr. 16 | Dec. 15 | July 29 | Sept. 10 |
| Dec. 19 | July 5 | Nov. 9 | Jan. 7 | Sept. 30 | Oct. 22 |
| May 2 | Oct. 18 | June 15 | Apr. 14 | Feb. 26 | Mar. 12 |

The amount and purpose of each check written or deposited in the bank during the 24 banking days were recorded in the proper sector according to the payer and payee of each check. In all, there were 25,725 checks in the sample. (The distribution of these checks among the sectors by expenditures and receipts is presented in appendix C, table 10.)

## Balancing of Receipts and Expenditures

The data from the checks first were summarized in a payments table indicating receipts and expenditures by sectors. A row (receipts) and a column (expenditures) were introduced in the table to indicate the discrepancy in the individual accounts, or the amount of imbalance between receipts and expenditures (table 3).

The discrepancy or imbalance in the individual sector accounts was small except for sector J (the sector including the bank). The check data failed to provide sufficient information on savings and loans within the

Table 3.-- Summary of receipts and expenditures for sample check data by economic sectors, Roger Mills County

| | | Receipts | | | | | | | | | | | Local | Non-local | Discrepancy | Total Receipts 1/ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | H | I | J | K | | | | |
| Expenditures | A | 45,437 | 1,652 | 5,264 | 592 | 258 | 1,272 | 287 | 60,906 | 353 | 396 | 241 | 116,658 | 289,380 | -- | 406,038 |
| | B | 13,518 | 1,617 | 3,293 | 3,336 | 1,071 | 5,189 | 2,226 | 3,089 | 683 | 3,277 | 539 | 37,838 | 38,052 | -- | 75,890 |
| | C | 17,505 | 1,121 | 8,583 | 672 | 529 | 1,339 | 702 | 365 | 188 | 590 | 141 | 31,735 | 62,335 | -- | 94,070 |
| | D | 16,730 | 12,451 | 5,550 | 1,422 | 1,447 | 851 | 704 | 1,133 | 185 | 1,109 | 318 | 41,900 | 3,476 | 1,081 | 46,457 |
| | E | 9,960 | 8,936 | 1,942 | 287 | 744 | 391 | 381 | 425 | 279 | 885 | 19 | 24,247 | 3,375 | 2,747 | 30,369 |
| | F | 47,058 | 3,672 | 5,587 | 909 | 610 | 6,878 | 2,917 | 2,713 | 234 | 1,347 | 288 | 72,213 | 31,013 | -- | 103,226 |
| | G | 12,866 | 4,052 | 2,177 | 817 | 414 | 622 | 3,470 | 2,337 | 426 | 1,304 | 181 | 28,666 | 9,714 | 3,924 | 42,304 |
| | H | 56,577 | 637 | 945 | 11 | 2 | 185 | 166 | 11,916 | -- | 830 | 25 | 71,294 | 62,103 | 7,166 | 140,563 |
| | I | 1,119 | 2,308 | 330 | 27 | 53 | 168 | 33 | 67 | 792 | 170 | -- | 5,067 | 1,273 | 2,019 | 8,359 |
| | J | 12,487 | 4,137 | 18,759 | 523 | 2,074 | 1,288 | 832 | 6,882 | 239 | 3,421 | 1,933 | 52,575 | 27,722 | -- | 80,297 |
| | K | 2,381 | 174 | 1,371 | 145 | 242 | 230 | 142 | 148 | 139 | 1,324 | 206 | 6,502 | 240 | 892 | 7,634 |
| Local | | 235,638 | 40,757 | 53,801 | 8,742 | 7,444 | 18,411 | 11,860 | 89,981 | 3,518 | 14,653 | 3,891 | 488,695 | 528,683 | 17,829 | 1,035,207 |
| Nonlocal | | 165,660 | 27,201 | 34,875 | 37,715 | 22,924 | 79,713 | 30,443 | 50,582 | 4,841 | 19,433 | 3,743 | 477,130 | xx | 51,553 | 528,683 |
| Discrepancy | | 4,741 | 7,932 | 5,394 | -- | -- | 5,103 | -- | -- | -- | 46,212 | -- | 69,382 | -- | xx | 69,382 |
| Total expenditures 1/ | | 406,039 | 75,890 | 94,070 | 46,457 | 30,368 | 103,227 | 42,303 | 140,563 | 8,359 | 80,297 | 7,634 | 1,035,207 | 528,683 | 69,382 | 1,633,272 |

1/ Items may not sum up to the total due to rounding.

local economy. Loans made by the bank were credited directly to the checking account of the individual or business receiving the loan. These transactions, however, were not included in the data recorded. Also, it was impossible to distinguish between expenditures to the bank for interest and repayment of loans and payments to the bank for increasing the checking or savings accounts. Such factors resulted in about $46,000 receipts by sector J in excess of expenditures. Although this discrepancy also includes any sampling error, it was assumed to be an estimate of savings by the various sectors, and was allocated to the sectors as a savings component to net incomes. 5/

Minor adjustments were made in the accounts of sectors B and F. Available secondary data indicated that, as estimated by the check data, sector B's expenditures for food, utilities, and personal services were unreasonably low. These expenditures were increased by the amount of the discrepancy ($7,932) for this sector's account. An audit of the accounts revealed that sector F sold more gas at retail than was purchased at wholesale. The wholesale purchases were increased to eliminate this discrepancy. The remaining differences in the accounts between receipts and expenditures were treated as sampling errors.

It was anticipated that a high volume of cash transactions would create the need for a separate investigation of the component of monetary flows. However, tabulation of the distribution of checks by sizes revealed that a very high proportion of the individual checks was less than $5 or $10 (see appendix C, table 11). On the basis of this information, it was decided that the cash transactions would create little bias in the results of this study. Therefore, a separate investigation of these transactions was not made.

## Classification of the Monetary Flows

The data from table 3 were transferred to a four-quadrant table which classifies the payments as follows (table 4):

(1) Quadrant I--Receipts by the various sectors for the final use of their goods for consumption, local government, or export;

(2) Quadrant II--Receipts and expenditures of the various sectors for intermediate products (inputs) for use in production of other production inputs and products or services;

(3) Quadrant III--Value of inputs used in production not produced in the local economy--labor, government, imports, and an imputed income for family and operator labor, fixed capital (including land), and management; and

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5/ This savings component represented only those made through the local bank. The savings component of insurance payments, or savings transferred directly into accumulation of capital items for future production or consumption, were not distinguishable from the expenditures for current production and consumption.

Table 4.--Classification of payments in sample by quadrants of input-output matrix, Roger Mills County 1/

| | Receipts (for endogenous sectors) | | | | | | | | | QII total | Receipts | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Expenditures | A | D | E | F | G | H | I | J | K | | Exogenous sectors (B&C) | Endogenous sectors | Nonlocal (export) | Discrepancy | QI total | Total receipts 2/ |
| | | | | Quadrant II | | | | | | | | Quadrant I | | | | |
| A | 31,393 | 370 | 10 | 99 | 27 | 59,405 | 88 | 22 | 98 | 91,512 | 6,915 | 18,231 | 289,380 | --- | 314,526 | 406,039 |
| D | 2,978 | 485 | 1,147 | 22 | 16 | 24 | 1 | 31 | 5 | 4,709 | 18,001 | 19,189 | 3,476 | 1,081 | 41,748 | 46,457 |
| E | 3,188 | --- | 312 | 6 | 8 | 161 | 45 | 210 | 5 | 3,935 | 10,878 | 9,434 | 3,375 | 2,747 | 26,433 | 30,368 |
| F | 34,135 | 155 | 261 | 4,507 | 829 | 735 | 61 | 331 | 42 | 41,056 | 9,259 | 21,900 | 31,013 | --- | 62,172 | 103,227 |
| G | 9,272 | 501 | 192 | 274 | 1,001 | 1,060 | 188 | 678 | 94 | 13,260 | 6,228 | 9,178 | 9,714 | 3,924 | 29,043 | 42,303 |
| H | 55,910 | --- | 2 | 97 | 83 | 9,603 | --- | 47 | 20 | 65,762 | 1,582 | 3,950 | 62,103 | 7,166 | 74,802 | 140,563 |
| I | 278 | --- | 21 | 46 | --- | --- | 7 | --- | --- | 352 | 2,638 | 2,077 | 1,273 | 2,019 | 8,007 | 8,359 |
| J | 7,809 | 159 | 1,094 | 771 | 308 | 4,824 | 73 | 1,234 | 283 | 16,555 | 22,896 | 13,123 | 27,722 | --- | 63,742 | 80,297 |
| K | 112 | --- | --- | --- | --- | --- | --- | --- | 93 | 205 | 1,545 | 4,752 | 240 | 892 | 7,429 | 7,634 |
| QII total (intermediate) | 145,075 | 1,670 | 3,039 | 5,822 | 2,272 | 75,812 | 463 | 2,553 | 640 | 237,346 | 79,944 | 101,833 | 428,296 | 17,829 | 627,901 | 865,247 |
| | | | | | Quadrant III | | | | | QIII Total | | Quadrant IV | | | QIV Total | |
| Wages | | | | | | | | | | | | | | | | |
| Endogenous | (9,602) | (970) | (259) | (2,426) | (1,414) | (4,599) | (590) | (637) | (1,719) | (22,218) | 5,549 | --- | 39,596 | --- | 45,145 | 73,626 |
| Exogenous | 9,643 | 3,342 | 1,024 | 4,984 | 2,163 | 3,045 | 653 | 3,109 | 518 | 28,481 | | | | | | |
| Imputed inputs | | | | | | | | | | | | | | | | |
| Endogenous | (49,937) | (2,095) | (2,546) | (3,635) | (5,245) | (6,116) | (1,593) | (7,596) | (852) | (79,615) | 7,317 | --- | 51,460 | --- | 58,777 | 68,977 |
| Exogenous | 7,643 | 229 | 229 | 642 | 325 | 197 | 128 | 647 | 160 | 10,200 | | | | | 11,079 | 27,356 |
| Local government | 13,737 | 437 | 347 | 901 | 439 | 213 | 90 | 111 | 2 | 16,277 | | | | | | |
| Nonlocal | | | | | | | | | | | | | | | | |
| Production | 115,733 | 33,203 | 21,273 | 69,706 | 26,722 | 46,078 | 2,474 | 11,738 | 1,668 | 328,595 | 62,076 | --- | --- | 51,553 | 113,629 | 528,683 |
| Consumption | 49,927 | 4,512 | 1,651 | 10,007 | 3,721 | 4,504 | 2,367 | 7,695 | 2,074 | 86,459 | | | | | | |
| Discrepancy | 4,741 | --- | --- | 5,104 | --- | --- | --- | 46,212 | --- | 56,056 | 13,325 | --- | --- | --- | 13,325 | 69,382 |
| QIII (inputs, net) | 201,424 | 41,723 | 24,524 | 91,344 | 33,372 | 54,036 | 5,712 | 69,511 | 4,422 | 526,068 | 90,016 | --- | 100,387 | 51,553 | 241,955 | 768,024 |
| QIII (inputs, gross) | (260,963) | (44,787) | (27,329) | (97,405) | (40,031) | (64,751) | (7,896) | (77,744) | (6,993) | (627,901) | | | | | | |
| Total expenditures, net 2/ | 346,499 | 43,393 | 27,563 | 97,166 | 35,644 | 129,348 | 6,175 | 72,064 | 5,063 | 763,414 | 169,959 | 101,833 | 528,683 | 69,382 | 869.856 | 1,633,272 |
| Total expenditures, gross 2/ | (406,039) | (46,457) | (30,368) | (103,227) | (42,303) | (140,563) | (8,359) | (80,297) | (7,634) | (865,247) | | | | | | |

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1/ See text for definition of quadrants.

2/ Items may not sum up to the total due to rounding.

(4) Quadrant IV--Value of output from the sectors entering directly into final use (without intermediate processing). 6/

The purpose of the payments as recorded on the checks was used in developing this classification of the data. For about 85 percent of the checks, the purpose was recorded or it could be inferred from the identity of the payee. The remaining payments (about 15 percent) were allocated between production and consumption purposes in accordance with the ratio of these payments as ascertained through the check data.

In this classification, sectors B and C were excluded from the production matrix (quadrant II) since they provided labor or government services entering directly into final demand (quadrant I). These were the exogenous sectors of the local economy. Of the endogenous sectors, sectors A (agriculture) and H (agri-business complex) provided most of the intermediate production in the County.

Cash payments for wages, government services, and nonlocal items for production and consumption were entered directly in quadrant III. The imputed returns were for family and operator labor, management, and fixed assets. These were estimated on the basis of expenditures of the households for consumption. The value of inputs used in production for final use (without intermediate processing) was entered in quadrant IV.

Quadrant I contains the "final demands" on the sectors of the County. These demands are the total receipts by sectors minus the intermediate production expenses (quadrant II) of the sectors.

To obtain the net incomes and local multipliers, the mathematical analysis of the data in table 4 included (1) computation of a trade matrix for intermediate production (appendix C, table 12), (2) inversion of this matrix to obtain the interdependence coefficients (appendix C, table 13), and (3) computation of a matrix of input coefficients for those inputs included in quadrant III (appendix C, table 14). An explanation of these mathematical procedures is presented in appendix B.

## RESULTS

The analysis of the data was for the major purpose of estimating (1) net incomes by local economic sectors, and (2) local secondary effects of primary farm and recreational income. A summary of the local-nonlocal trade relations for the County was developed because of the influence of these relations on the size of local multipliers.

### Net Income by Sectors

The procedures employed permitted the derivation of the relationship between gross and net income, and the average net income per economic unit for each sector in the local economy.

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6/ This classification system was obtained from H. E. Chenery and P. G. Clark, Interindustry Economics, John Wiley and Sons, New York, 1959, pp. 16-17.

The primary input coefficients (appendix C, table 14), developed from the basic from-to matrix (table 4), provided an estimate of the local and nonlocal expenditures for consumption per dollar of gross receipts to each sector. 7/ If there were no savings, then consumption would be equal to net income. In this study, net income is the sum of consumption and savings. It is gross receipts minus production expenses and personal and business taxes. In the terminology of national income accounting, the net income as used in this study is disposable income. For agriculture, the consumption coefficients were 0.141808 for local and 0.122961 for nonlocal goods and services. Thus, an estimated $0.264769 out of every dollar of gross income to agriculture was accounted for in the consumption component of net income (table 5). These consumption coefficients also provided the basis for computing the returns to management, fixed capital, and family and operator labor. The return to these inputs was $2,492 per economic unit in the agricultural sector (table 5). A savings component was then added to the consumption estimates to derive an estimate of total net income by sectors and the average return per household within each sector. 8/

The net incomes obtained by these procedures were compared with income data in the 1960 Census of Population. 9/ The Census estimate of median family income for farmers and farm managers in Roger Mills County was $2,535, whereas the total net income per agricultural household in this study was an estimated $2,529. The average net income per economic unit in the sample was $3,213. The median family income reported in the Census for all sectors of Roger Mills County was $2,976.

Although Census income data were not available for sectors other than agriculture for Roger Mills County, the estimates derived for these sectors in the sample appeared to be realistic. The highest net incomes were to the following sectors: (1) professional services (sector J); (2) lumber yards, construction companies, etc. (sector G); and (3) elevators, livestock auctions, and trucking companies (sector H). The sectors receiving the lowest net incomes were: (1) agriculture (sector A); (2) personal services (sector I); and (3) grocery stores and cafes (sector D). Sectors B and C were not included in the matrix for computing primary input coefficients. However, direct receipts by these sectors amounted to $2,265 and $3,282 per household, respectively.

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7/ These coefficients are computed by dividing the expenditures for primary inputs in each sector (quadrant III, table 4) by gross receipts to the sector. The local consumption expenditures by agriculture of $57,579.56 was divided by the gross receipts to agriculture of $406,038.61 to derive the local consumption coefficient of 0.141808.

8/ Savings were estimated to be 1.5 percent of the consumption component of net income for each sector. This estimated percentage was based on the unallocated residual in the sector which included the County's major financial institution and is therefore only an estimate of cash savings.

9/ Bureau of Census, "General Social and Economic Characteristics," Census of Population: 1960, XXXVIII. U.S. Dept. Commerce, Washington, D.C., 1960. It must be recognized that income as reported in the Census is not directly comparable to net incomes as used in this study. Thus, the comparisons are presented only to depict the "reasonableness" of the general magnitude of net incomes obtained from use of check data in this study.

Table 5.--Estimated net income per economic unit by sectors from sample data, Roger Mills County, 1960

| Item | A | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|
| Consumption coefficients 1/ | 0.264769 | 0.147147 | 0.145760 | 0.138373 | 0.219656 | 0.076955 | 0.489106 | 0.198496 | 0.404273 |
| Gross receipts (dollars) 2/ | 5,176,992 | 592,326 | 387,192 | 1,316,150 | 539,367 | 1,792,183 | 106,575 | 1,023,788 | 97,331 |
| Income to management, capital, and family and operator labor (dollars) 3/ | 1,370,707 | 87,159 | 56,437 | 182,120 | 118,475 | 137,917 | 52,126 | 203,218 | 39,348 |
| Estimated number of economic units in sample | 550 | 31 | 15 | 26 | 12 | 15 | 18 | 17 | 7 |
| Consumption component of net income per unit (dollars) 4/ | 2,492 | 2,812 | 3,762 | 7,004 | 9,872 | 9,194 | 2,896 | 11,954 | 5,621 |
| Estimated savings per unit (dollars) | 37 | 41 | 55 | 103 | 146 | 136 | 43 | 176 | 83 |
| Total net income per unit (dollars) | 2,529 | 2,853 | 3,817 | 7,107 | 10,018 | 9,330 | 2,939 | 12,130 | 5,704 |

1/ Sum of local and nonlocal consumption coefficients from appendix C, table 14.

2/ Estimated annual gross receipts for each sector. (Sample data multiplied by 12.75 to determine annual equivalents.)

3/ Consumption coefficients times gross receipts by sectors.

4/ Income to management, capital, and family and operator labor divided by estimated number of economic units in sample.

## Local Secondary Effects of Increases in Agricultural and Recreational Income

The estimates of net income provide the basis for measuring the effects of comparable increases in final demands to agricultural and recreational services. These effects are measured in terms of changes in gross receipts and net incomes of the sectors. An increase in total gross receipts to agriculture of $100,000 first is assumed. This $100,000 is made up of two components: (1) a sum of $85,997, representing initial gross receipts to farmers; and (2) a sum of $14,003, representing the farm sector's share of gross receipts arising from multiplier effects. For purposes of comparison, it then is assumed that an initial increase of $85,997 in gross receipts occurs to sectors servicing the recreation industry in the County.

### Effect of Increases in Agricultural Income

The assumed $100,000 increase in agricultural gross income accounts for both the direct gross income ($85,997) and the indirect gross income ($14,003) which arise as a result of the interdependent relations in the local economy (table 6). Specifically, the direct gross receipts consist of the initial external payments to the agricultural sector. The indirect gross receipts result from trade within the agricultural sector and from increases in payments to agriculture by the other sectors. For example, an initial external payment to agriculture increases that sector's "first round" payments to other sectors in the economy. This, in turn, stimulates these sectors to increase their payments—a portion of which returns to agriculture as indirect gross receipts.

The direct gross receipts to the other local sectors (B through K) are the estimated first round payments of agriculture to these sectors. Sector F (gas stations, garages, and its other units), for example, receives first round payments of $11,590 from the original stimulus to agriculture of $85,997. That is, sector F receives slightly over $0.13 from each dollar of external payments to agriculture. The second and subsequent rounds of payments give rise to the indirect gross receipts to the various local sectors.

Total gross receipts in the local area resulting from an initial external payment of $85,997 to agriculture are an estimated $177,845. Thus, there is local gross income of $2.07 for each dollar of direct gross receipts to agriculture. Similarly, there is $1.78 of gross income in the local economy for each dollar of total gross receipts to agriculture.

The next step in the analysis was to determine the net incomes associated with the increase in gross income. The coefficients in table 5 were used to determine the consumption component of net income for each of the local sectors. 10/ Total net income was determined by adding a cash savings

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10/ The consumption component of net income for agriculture, for example, is derived by multiplying the $100,000 in total gross receipts by the consumption coefficient of 0.264769 (table 5).

Table 6.--Estimates of increases in income to the various local sectors of Roger Mills County associated with $100,000 increase in total gross receipts to agriculture

| Sector 1/ | Gross receipts | | | Net income | | | |
|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Consumption | Savings | Total | Percentage of total |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Percent |
| A---------- | 85,997 | | | 22,769 | 335 | 23,104 | 53.3 |
| | | 14,003 | | 3,708 | 55 | 3,763 | 8.7 |
| | | | 100,000 | 26,477 | 390 | 26,867 | 62.0 |
| B---------- | 3,330 | 311 | 3,641 | 3,440 | 51 | 3,491 | 8.1 |
| C---------- | 4,310 | 54 | 4,364 | 3,690 | 54 | 3,744 | 8.6 |
| D---------- | 4,120 | 779 | 4,899 | 721 | 11 | 732 | 1.7 |
| E---------- | 2,450 | 819 | 3,269 | 476 | 7 | 483 | 1.1 |
| F---------- | 11,590 | 8,944 | 20,534 | 2,841 | 42 | 2,883 | 6.7 |
| G---------- | 3,170 | 2,517 | 5,687 | 1,249 | 18 | 1,267 | 2.9 |
| H---------- | 13,930 | 14,795 | 28,725 | 2,211 | 33 | 2,244 | 5.2 |
| I---------- | 280 | 158 | 438 | 214 | 3 | 217 | .5 |
| J---------- | 3,080 | 2,590 | 5,670 | 1,125 | 17 | 1,142 | 2.6 |
| K---------- | 590 | 28 | 618 | 250 | 4 | 254 | .6 |
| All local except sector A-- | 46,850 | 30,995 | 77,845 | 16,217 | 240 | 16,457 | --- |
| All local-- | 132,847 | 44,998 | 177,845 | 42,694 | 630 | 43,324 | 100.0 |
| Local income per dollar of direct farm income------------ | | | 2.07 | 1.88 | --- | 1.88 | --- |
| Local income per dollar of total farm income------------- | | | 1.78 | 1.62 | --- | 1.62 | --- |

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1/ See table 1 for a listing of economic units included in each of the sectors.

component which was assumed to be a constant percentage of consumption net income. These computations indicated that there was an increase in local net income to agriculture of $0.27 for each dollar increase in total gross receipts to that sector. When the net incomes of the other sectors were included, this figure increased to $0.43 for each dollar increase in agriculture's total gross income.

Table 6 also indicates an increase in net income of $1.88 to the local economy for each dollar increase of direct net income to agriculture. Similarly, local net income of $1.62 is generated in the local economy for each dollar of total net farm income. These estimates are the local net income multipliers for the County.

The distribution of the net income associated with a $100,000 increase in total gross receipts indicates that the direct beneficiary, agriculture, receives 62 percent of the increase in net income. The remaining net income is distributed to the other sectors in the local economy, with sectors B, C, F, and H being the major recipients of this income.

The local multiplier effects were developed within a static framework and for a specific local economy. Thus, they are irrelevant as indicators of the multiplier effects in other local areas which exhibit significantly different economic characteristics. In addition to the variability among local areas at one point in time, local economies change over time. Consideration must also be given to dynamic factors affecting the basic structural relationships within these economies.

### Effect of Increases in Recreational Income

To provide a comparison with the agricultural example, the same procedures are used to determine the increase in income associated with an increase in recreational expenditures (table 7). Data from a recent study on recreation in Roger Mills County provided estimates of payments to local businesses by nonresident users of the upstream reservoirs for recreation purposes (see footnote 3). These payments by nonresidents are exports; thus, they are direct gross receipts to the affected sectors. According to this recreational study, the direct gross income of $85,997 is distributed among the sectors as follows: sector D, $46,516; sector E, $284; sector F, $27,915; sector G, $5,641; and sector I, $5,641.

The local gross income per dollar of direct and total recreational income is much smaller than for agriculture. That is, there is only $1.17 in gross income to the economy per dollar of direct recreational receipts, and $1.13 per dollar of total receipts. Comparable figures in the agricultural example were $2.07 and $1.78. Thus, there is a smaller multiplier effect (a greater amount of leakage) associated with recreational income than that associated with agricultural receipts.

The net incomes associated with increases in recreational receipts were determined in the same manner as for those in agriculture income. The large amount of leakage associated with recreation expenditures was apparent in

Table 7.--Estimates of increases in income to the various local sectors of Roger Mills County associated with an increase in recreational expenditures

| Sectors 1/ | Gross receipts | | | Net income | | | |
|---|---|---|---|---|---|---|---|
| | Direct | Indirect | Total | Consumption | Savings | Total | Percentage of total |
| | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Percent |
| D | 46,516 | 518 | 47,034 | 6,921 | 102 | 7,023 | 29.9 |
| E | 284 | 43 | 327 | 48 | 1 | 49 | .2 |
| F | 27,915 | 1,671 | 29,586 | 4,094 | 60 | 4,154 | 17.7 |
| G | 5,641 | 888 | 6,529 | 1,434 | 21 | 1,455 | 6.2 |
| I | 5,641 | 19 | 5,660 | 2,768 | 41 | 2,809 | 11.9 |
| Total sectors directly affected | 85,997 | | | 14,748 | 217 | 14,965 | 63.7 |
| | | 3,139 | | 517 | 8 | 525 | 2.2 |
| | | | 89,136 | 15,265 | 225 | 15,490 | 65.9 |
| A | 1,237 | 564 | 1,801 | 477 | 7 | 484 | 2.0 |
| B | 5,596 | 531 | 6,127 | 5,789 | 85 | 5,874 | 25.0 |
| C | 1,305 | 60 | 1,365 | 1,154 | 17 | 1,171 | 5.0 |
| H | 101 | 127 | 228 | 18 | --- | 18 | .1 |
| J | 1,217 | 514 | 1,731 | 344 | 5 | 349 | 1.5 |
| K | 315 | --- | 315 | 127 | 2 | 129 | .5 |
| Total sectors indirectly affected | 9,771 | 1,796 | 11,567 | 7,909 | 116 | 8,025 | --- |
| Total sectors | 95,768 | 4,935 | 100,703 | 23,174 | 341 | 23,515 | 100.0 |
| Local income per dollar of direct recreational income | | | 1.17 | 1.57 | | 1.57 | --- |
| Local income per dollar of total recreational income | | | 1.13 | 1.52 | | 1.52 | --- |

1/ See table 1 for a listing of economic units included in each of the sectors.

that only $0.17 of net income was obtained per dollar of gross recreational receipts; total net income to the local economy was $0.26 per dollar of gross receipts from recreation. Comparable figures in the agricultural example were $0.27 and $0.43.

The distribution of net income resulting from increased recreation income suggests that the direct beneficiaries (sectors D, E, F, G, and I) retain about 70 percent, whereas the major indirect beneficiaries, the wage earners (sector B), retain 25 percent of the net income (table 7).

## Balance of Trade for the Local Area

The identification of receipts and expenditure data by purpose provided a basis for developing a balance of trade table for Roger Mills County (table 8). Livestock and livestock products account for over 60 percent of the net positive balance of trade. The net export of labor accounts for an additional 15 percent of the net positive balance.

The import-export relationship inherent in the balance of trade table provided one indicator of the adjustments needed to increase the magnitude of the multiplier effect in the local economy. The extremely high percentage of consumption inputs purchased outside the local area tended to depress the size of the local multiplier. That is, a more favorable balance of trade and a higher local multiplier effect would result if the residents of the area purchased more of their production and consumption inputs locally.

## IMPLICATIONS FOR WATERSHED DEVELOPMENT

This study demonstrates the dependence of secondary effects upon: (1) the primary benefits (in gross income equivalents) by source, and (2) the characteristics of the local economy.

The multipliers estimated for Roger Mills County are functionally related to gross monetary receipts and the disposal of these receipts by the various sectors. The net income multipliers depend partly upon how the various sectors allocate expenditures between production and consumption (plus savings) purposes. This allocation for particular sectors, such as agriculture (sector A), can vary considerably without affecting significantly the aggregate local income of all local nonfarm sectors. For example, in this study, farm households allocated an estimated 73 percent of their gross receipts to production expenses and taxes and 27 percent to consumption and savings. Suppose the allocation had been the reverse--i.e., 73 percent to consumption and savings, and 27 percent to production and taxes. Then, how would the assumed $100,000 increase in gross receipts to farmers affect net income to the other sectors? It is possible that the aggregate increase of $16,457 in net income to the nonfarm sectors would be approximately the same in either case. However, with the higher amount going to net income, it would be allocated differently among the nonfarm sectors than estimated in this study. That is, businesses selling consumption items, rather than those selling production items, would gain the greater share of the secondary net income.

Table 8.--Balance of trade for Roger Mills County

| Item | Imports | Exports | Net balance of trade |
|---|---|---|---|
| | 1,000 dollars | 1,000 dollars | 1,000 dollars |
| Labor | 38 | 714 | 676 |
| Rent | 153 | 71 | -82 |
| Grain, cotton, feed, seed, and fertilizer | 625 | 557 | -68 |
| Livestock | 544 | 2,194 | 1,650 |
| Livestock products | --- | 1,012 | 1,012 |
| Custom work and hauling | 38 | 226 | 188 |
| Gas and oil | 589 | 179 | -410 |
| Repairs and parts | 330 | 49 | -281 |
| Lumber and plumbing | 405 | 60 | -345 |
| Machines and automobiles | 407 | 133 | -274 |
| General supplies | 213 | --- | -213 |
| Veterinary and drugs | 69 | 14 | -55 |
| Utilities | 153 | 31 | -122 |
| Insurance | 236 | 82 | -154 |
| Grocery and cafe purchases | 459 | 23 | -436 |
| Medical and funeral services | 101 | 24 | -77 |
| Other professional services | 32 | 14 | -18 |
| Literature and education | 69 | 1 | -68 |
| Personal services | 27 | --- | -27 |
| Furniture | 56 | --- | -56 |
| Clothing | 219 | 14 | -205 |
| Mail order store products | 67 | --- | -67 |
| Gifts and contributions | 34 | 13 | -21 |
| Taxes | 499 | 119 | -380 |
| Government payments | --- | 228 | 228 |
| Social security and welfare | --- | 436 | 436 |
| Oil leases | --- | 192 | 192 |
| Cash and miscellaneous | 721 | 355 | -366 |
| Total | 6,034 | 6,741 | 657 |
| Balance of trade and discrepancy | 657 | --- | 657 |
| Total | 6,741 | 6,741 | --- |

Because of such considerations, direct application of the net income multipliers as estimated in this study would be inappropriate for estimating the ratio of local nonfarm (secondary) net income to primary net farm income from the watershed projects. 11/ A more appropriate application of the results of this study would be to convert the primary benefits to gross receipts to farmers, and apply the relation of these gross receipts to net nonfarm income. In this study, this relation was about \$0.16 in net local secondary income per dollar of gross primary benefits to farmers. 12/ A comparable relation for recreation was \$0.09 per dollar of gross receipts for export of recreational services.

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11/ Primary benefits of projects as estimated by the Soil Conservation Service are not comparable to the net incomes as used in this study. Primary benefits reported in the work plans include both monetary and nonmonetary effects, and they are estimated for a "marginal" acreage of the farms instead of "whole farms."

12/ For this relation, both direct and indirect farm income was included in gross primary benefits to farmers. The \$0.16 was obtained by dividing the total net income to sectors other than A (\$16,457) by the \$100,000 increase in gross receipts to farmers (table 6). (The figure cited for recreation was obtained by the same method.)

## APPENDIX A

## National and Local Income Associated with Farmer Expenditures

The first step in explaining the relation of local and national income associated with farmer expenditures is to express the relationship of national farmer expenditures to national income (fig. 1). For this purpose, the vertical axis of figure 1 means expenditures by all farmers per unit of time (year). The horizontal axis represents gross receipts of all farmers of the Nation per unit of time (year). The 45-degree line OA indicates a 1 to 1 relationship between gross receipts and expenditures. If there are savings, unilateral transfers, etc., causing the rate of spending by farmers to be less than the rate of gross receipts, then the spending function OS will lie below OA in the region of gross receipts obtained (OR). The slope of the spending function OS is the marginal propensity of farmers to spend. In this study, the average rather than the marginal propensity to spend was used to obtain the multipliers; thus, in the figure, the average would be expressed by the ratio $\frac{RB}{RA}$. If RB is 0.8 of RA, then, on the average, there is a farmer expenditure of $8 for each $10 of gross receipts. The spending by farmers is for both production and consumption, and what is spent by farmers represents gross receipts to other sectors of the economy. If we assume the same relation of expenditures to gross receipts for the nonfarm sectors (say 0.8), then each $8 of farmer expenditures is associated with a total expenditure of $40 in the economy. A payments multiplier of 5 follows from the formula:

$$(1) \quad me = e + ke + ke^2 + ke^3 + - - - + ke^n$$

where m is the multiplier, e is an initial expenditure, and k is the ratio of expenditures to receipts. 13/ This formula reduces to:

$$(2) \quad m = \frac{1}{1-k}$$

The next step is to relate the local to the national farmer expenditures multiplier. For simplicity, assume the total spending patterns in Roger Mills County to be typical of those in the Nation, that is, each sector spends 80 percent of its receipts in a given period of time. However, only some fraction of this expenditure is local. In figure 1, assume RC is the local (County) expenditure and CB is the nonlocal expenditure. Then, the vector OC represents an average propensity to spend locally, and the local payments multiplier will be:

$$(3) \quad m' = \frac{1}{1-k'}$$

where k' is $\frac{RC}{RB}$.

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13/ Cf. Boulding, Kenneth E. A Reconstruction of Economics. John Wiley and Sons, New York, 1950, pp. 206-242.

Therefore, the difference between the national (m) and the local (m') payments multipliers is accounted for by nonlocal expenditures made by residents in the local area.

In this study, the relation of total expenditures to total receipts by local sectors was not determined because of inability to accurately distinguish savings and consumption. However, to determine such a relation was unnecessary for expressing the local multiplier; it was necessary only for the estimate of total receipts and expenditures outside the County. Only the estimation of net incomes associated with gross receipts was required to obtain net local multipliers.

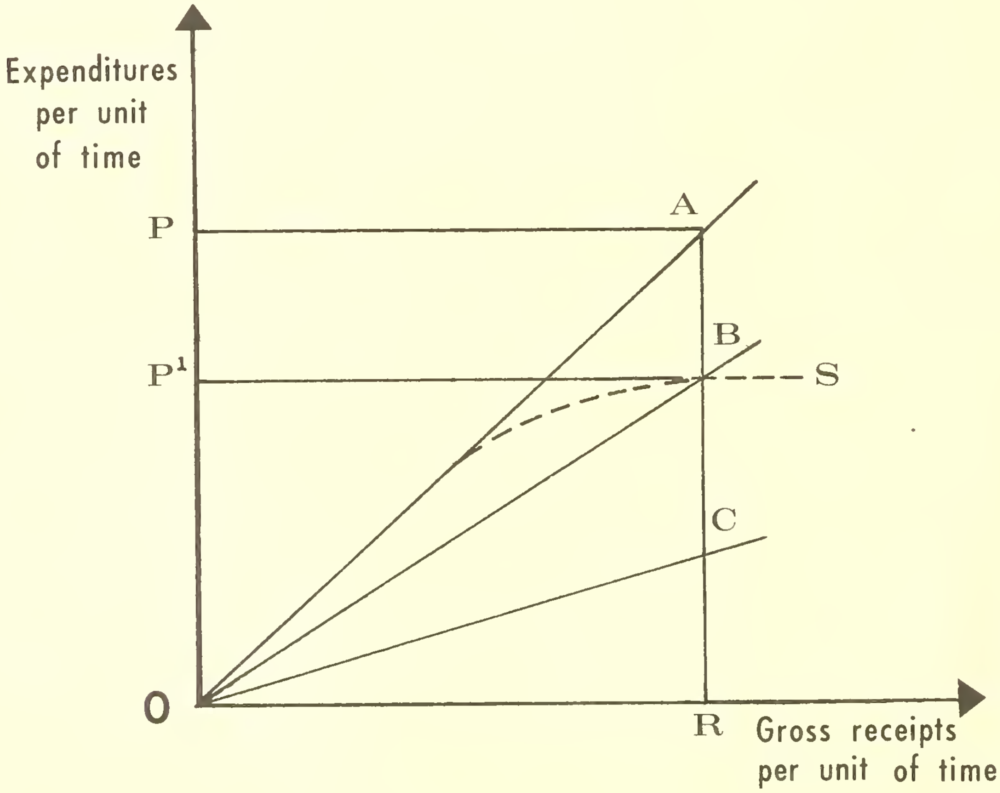
Expenditures per unit of time
P
A
B
P¹
S
C
0
R
Gross receipts per unit of time

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Figure 1.--Graphical illustration of relations between expenditures and receipts (national and local).

## APPENDIX B

## Mathematical Procedures

The local economy is classified into n + 1 sectors; n of these participate in intermediate production (endogenous sectors). The remaining sector is a composite of exogenous sectors (local consumption, local government, and exports) whose payments go directly into final demand.

Let the gross receipts of the $i^{th}$ endogenous sector be designated as $X_i$. Let $X_{ij}$ designate the receipts of the $i^{th}$ endogenous sector from the $j^{th}$ endogenous sector. The remainder of the receipts to the $i^{th}$ sector are payments from the exogenous sector for final use of goods and services. These payments are designated as $Y_i$. The system of linear equations for the local economy, therefore, is as follows:

$$(1)\quad \begin{array}{ccccccccccc}
X_1 & = & X_{11} & + & X_{12} & + & X_{13} & + - - - - + & X_{1n} & + & Y_1 \\
X_2 & = & X_{21} & + & X_{22} & + & X_{23} & + - - - - + & X_{2n} & + & Y_2 \\
\vdots & & \vdots & & \vdots & & \vdots & & \vdots & & \vdots \\
X_n & = & X_{n1} & + & X_{n2} & + & X_{n3} & + - - - - + & X_{nn} & + & Y_n
\end{array}$$

This system of equations is consistent with the design of quadrants I and II of appendix B, table 9. In this table, quadrant III accounts for the primary inputs not produced by the endogenous sectors (quadrant II); quadrant IV contains the payments to primary factors assigned directly to final use. The individual items in the table are defined symbolically.

Expenditures by any given endogenous sector to other endogenous sectors are assumed to be a linear function of total receipts of that sector. In symbolic notation, the receipts of the $i^{th}$ sector from $j^{th}$ sector ($X_{ij}$) are proportional to the gross receipts of the $j^{th}$ sector or:

$$(2)\quad \frac{X_{ij}}{X_j} = a_{ij} \text{ or } X_{ij} = a_{ij}X_j$$

Substituting from equation 2 into equation 1, the following coefficients are obtained:

$$(3)\quad \begin{array}{ccccccccc}
X_1 & = & a_{11}X_1 & = & a_{12}X_2 & + - - - - + & a_{1n}X_n & + & Y_1 \\
X_2 & = & a_{21}X_1 & + & a_{22}X_2 & + - - - - + & a_{2n}X_n & + & Y_2 \\
\vdots & & \vdots & & \vdots & & \vdots & & \vdots \\
X_n & & a_{n1}X_1 & + & a_{n2}X_2 & + - - - - + & a_{nn}X_n & + & Y_n
\end{array}$$

Table 9.--Symbolic expression of classification of payments by quadrants of input-output matrix

| To / From | Local intermediate users |  |  | Local receipts for intermediate inputs | Household (consumption) | Local government | Exports | Receipts to final use | Total receipts |
|---|---|---|---|---|---|---|---|---|---|
|  | A | j | H |  | K | L | N |  |  |
|  | Quadrant II |  |  |  |  | Quadrant I |  |  |  |
| A | $X_{aa}$ | $X_{aj}$ | $X_{ah}$ | $\sum_{j=A}^{H} X_{aj}$ | $Y_{ak}$ | $Y_{al}$ | $Y_{an}$ | $\sum_{j=K}^{N} Y_{aj}$ | $\sum_{j=A}^{H} X_{aj} + \sum_{j=K}^{N} Y_{aj}$ |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| i | $X_{ia}$ | $X_{ij}$ | $X_{ih}$ | $\sum_{j=A}^{H} X_{ij}$ | $Y_{ik}$ | $Y_{il}$ | $Y_{in}$ | $\sum_{j=K}^{N} Y_{ij}$ | $\sum_{j=A}^{H} X_{ij} \quad \sum_{j=K}^{N} Y_{ij}$ |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| H | $X_{ha}$ | $X_{hj}$ | $X_{hh}$ | $\sum_{j=A}^{H} X_{hj}$ | $Y_{hk}$ | $Y_{hl}$ | $Y_{hn}$ | $\sum_{j=K}^{N} Y_{hj}$ | $\sum_{j=A}^{H} X_{hj} + \sum_{j=K}^{N} Y_{hj}$ |
| Total expenditures for intermediate inputs | $\sum_{i=A}^{H} X_{ia}$ | $\sum_{i=A}^{H} X_{ij}$ | $\sum_{i=A}^{H} X_{ih}$ | $\sum_{i=A}^{H} \sum_{j=A}^{H} X_{ij}$ | $\sum_{i=A}^{H} Y_{ik}$ | $\sum_{i=A}^{H} Y_{il}$ | $\sum_{i=A}^{H} Y_{in}$ | $\sum_{i=A}^{H} \sum_{j=K}^{N} Y_{ij}$ | $\sum_{i=A}^{H} \sum_{j=A}^{H} X_{ij} + \sum_{i=A}^{H} \sum_{j=K}^{N} Y_{ij}$ |
|  | Quadrant III |  |  |  |  | Quadrant IV |  |  |  |
| Households (labor) K | $X_{ka}$ | $X_{kj}$ | $X_{kh}$ | $\sum_{j=A}^{H} X_{kj}$ | $Y_{kk}$ | $Y_{kl}$ | $Y_{kn}$ | $\sum_{j=K}^{N} Y_{kj}$ | $\sum_{j=A}^{H} X_{kj} \quad \sum_{j=K}^{N} Y_{kj}$ |
| Local government L | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| Imputed returns M | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| Imports N | $X_{na}$ | $X_{nj}$ | $X_{nh}$ | $\sum_{j=A}^{H} X_{nj}$ | $Y_{nk}$ | $Y_{nl}$ | $Y_{nn}$ | $\sum_{j=K}^{N} Y_{nj}$ | $\sum_{j=A}^{H} X_{nj} \quad \sum_{j=K}^{N} Y_{nj}$ |
| Total primary inputs | $\sum_{i=K}^{N} X_{ia}$ | $\sum_{i=K}^{N} X_{ij}$ | $\sum_{i=K}^{N} X_{ih}$ | $\sum_{i=K}^{N} \sum_{j=A}^{H} X_{ij}$ | $\sum_{i=K}^{N} Y_{ik}$ | $\sum_{i=K}^{N} Y_{il}$ | $\sum_{i=K}^{N} Y_{in}$ | $\sum_{i=K}^{N} \sum_{j=K}^{N} Y_{ij}$ | $\sum_{i=K}^{N} \sum_{j=A}^{H} X_{ij} + \sum_{i=K}^{N} \sum_{j=K}^{N} Y_{ij}$ |
| Total expenditures | $\sum_{i=A}^{N} X_{ia}$ | $\sum_{i=A}^{N} X_{ij}$ | $\sum_{i=A}^{N} X_{in}$ | $\sum_{i=A}^{N} \sum_{j=A}^{H} X_{ij}$ | $\sum_{i=A}^{N} Y_{ik}$ | $\sum_{i=A}^{N} Y_{il}$ | $\sum_{i=A}^{N} Y_{in}$ | $\sum_{i=A}^{N} \sum_{j=K}^{N} Y_{ij}$ | $\sum_{i=A}^{N} \sum_{j=A}^{H} X_{ij} + \sum_{i=A}^{N} \sum_{j=K}^{N} Y_{ij}$ |

or, in matrix notation:

(4a) $X = AX + Y$, or
(4b) $X = AX = Y$

Equation 4b is used to determine the gross receipts associated with a given amount of payments to the exogenous sector (or receipts to final demand). This equation can be restated as:

(5a) $X (I-A) = Y$, or
(5b) $X = (I-A) Y$

where $I$ is an identity matrix of the same dimension as the $A$ matrix. Let $(I-A)^{-1} = A^*$, then

(6) $X = A^* Y$

In this form, specified changes in final demand can be inserted into equation 6 to solve for the level of gross receipts.

A similar mathematical approach was used to compute the primary input coefficients; that is, the functional relation between a sector's gross receipts and expenditures for primary inputs (quadrant III) is assumed to be linear. Then, changes in net income to various sectors were computed directly.

## APPENDIX C

## Selected Tables

Table 10.-- Distribution of checks in sample, among sectors of Roger Mills County, by expenditures and receipts

| | Receipts of sectors | | | | | | | | | | | Local | Non-local | Total receipts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Expenditures of sectors | A | B | C | D | E | F | G | H | I | J | K | | | |
| A | 696 | 65 | 163 | 24 | 8 | 21 | 20 | 195 | 10 | 20 | 44 | 1,266 | 1,020 | 2,286 |
| B | 459 | 97 | 133 | 74 | 41 | 99 | 53 | 89 | 45 | 85 | 25 | 1,200 | 593 | 1,793 |
| C | 580 | 92 | 180 | 30 | 13 | 64 | 30 | 25 | 21 | 67 | 12 | 1,114 | 447 | 1,561 |
| D | 1,664 | 342 | 300 | 34 | 19 | 66 | 57 | 69 | 16 | 77 | 15 | 2,659 | 204 | 2,863 |
| E | 1,052 | 276 | 256 | 37 | 15 | 37 | 46 | 57 | 30 | 76 | 6 | 1,888 | 191 | 2,079 |
| F | 1,760 | 255 | 231 | 21 | 18 | 104 | 73 | 70 | 17 | 76 | 12 | 2,637 | 324 | 2,961 |
| G | 317 | 83 | 90 | 30 | 13 | 34 | 37 | 23 | 19 | 47 | 15 | 708 | 103 | 811 |
| H | 800 | 39 | 46 | 2 | 1 | 3 | 1 | 28 | -- | 9 | 2 | 931 | 208 | 1,139 |
| I | 229 | 53 | 79 | 9 | 4 | 15 | 15 | 13 | 18 | 45 | -- | 480 | 66 | 546 |
| J | 522 | 127 | 141 | 21 | 30 | 38 | 39 | 42 | 19 | 68 | 31 | 1,078 | 493 | 1,571 |
| K | 232 | 52 | 161 | 25 | 26 | 27 | 23 | 19 | 15 | 97 | 19 | 696 | 27 | 723 |
| Local | 8,311 | 1,481 | 1,780 | 307 | 188 | 508 | 394 | 630 | 210 | 667 | 181 | 14,657 | 3,676 | 18,333 |
| Nonlocal | 3,728 | 911 | 729 | 426 | 184 | 417 | 211 | 268 | 110 | 312 | 96 | 7,392 | xxx | 7,392 |
| Total expenditures | 12,039 | 2,392 | 2,509 | 733 | 372 | 925 | 605 | 898 | 320 | 979 | 277 | 22,049 | 3,676 | 25,725 |

Table 11.-- Distribution of expenditures by size of checks, Roger Mills County

| Range (dollars) | Local expenditures to local sectors | | | Local expenditures to nonlocal sectors | | |
|---|---|---|---|---|---|---|
| | Number of checks | Percent of checks | Cumulative percent | Number of checks | Percent of checks | Cumulative percent |
| 0 - 5.00 | 6,488 | 44.3 | 44.3 | 1,879 | 25.4 | 25.4 |
| 5.01 - 10.00 | 2,890 | 19.7 | 64.0 | 1,500 | 20.3 | 45.7 |
| 10.01 - 25.00 | 2,343 | 16.0 | 80.0 | 1,766 | 23.9 | 69.6 |
| 25.01 - 50.00 | 1,166 | 8.0 | 88.0 | 788 | 10.7 | 80.3 |
| 50.01 - 100.00 | 838 | 5.7 | 93.7 | 575 | 7.8 | 88.1 |
| 100.01 - 200.00 | 437 | 3.0 | 96.7 | 416 | 5.6 | 93.7 |
| 200.01 - 300.00 | 172 | 1.2 | 97.9 | 149 | 2.0 | 95.7 |
| 300.01 - 500.00 | 125 | .8 | 98.7 | 121 | 1.6 | 97.3 |
| 500.01 - 1000.00 | 96 | .6 | 99.3 | 93 | 1.3 | 98.6 |
| 1000.01 + | 102 | .7 | 100.0 | 105 | 1.4 | 100.0 |
| Total | 14,657 | 100.0 | xxx | 7,392 | 100.0 | xxx |

| Range (dollars) | Nonlocal expenditures to local sectors | | | Expenditures by all sectors | | |
|---|---|---|---|---|---|---|
| | Number of checks | Percent of checks | Cumulative percent | Number of checks | Percent of checks | Cumulative percent |
| 0 - 5.00 | 685 | 18.6 | 18.6 | 9,052 | 35.2 | 35.2 |
| 5.01 - 10.00 | 381 | 10.4 | 29.0 | 4,771 | 18.5 | 53.7 |
| 10.01 - 25.00 | 490 | 13.3 | 42.3 | 4,599 | 17.9 | 71.6 |
| 25.01 - 50.00 | 430 | 11.7 | 54.0 | 2,384 | 9.3 | 80.9 |
| 50.01 - 100.00 | 650 | 17.7 | 71.7 | 2,063 | 8.0 | 88.9 |
| 100.01 - 200.00 | 479 | 13.0 | 84.7 | 1,332 | 5.2 | 94.1 |
| 200.01 - 300.00 | 150 | 4.1 | 88.8 | 471 | 1.8 | 95.9 |
| 300.01 - 500.00 | 156 | 4.2 | 93.0 | 402 | 1.6 | 97.5 |
| 500.01 - 1000.00 | 139 | 3.8 | 96.8 | 328 | 1.3 | 98.8 |
| 1000.00 + | 116 | 3.2 | 100.0 | 323 | 1.2 | 100.0 |
| Total | 3,676 | 100.0 | xxx | 25,725 | 100.0 | xxx |

Table 12.--Matrix of trade coefficients for intermediate production, for sample data, Roger Mills County

| Sectors | Sectors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | D | E | F | G | H | I | J | K |
| A-------- | 0.077315 | 0.007956 | 0.000329 | 0.000967 | 0.000640 | 0.422626 | 0.010468 | 0.000270 | 0.012839 |
| D-------- | .007334 | .010438 | .037758 | .000218 | .000366 | .000167 | .000209 | .000391 | .000677 |
| E-------- | .007851 | .000000 | .010258 | .000058 | .000177 | .001115 | .005398 | .002612 | .000665 |
| F-------- | .084067 | .003343 | .008608 | .043658 | .019604 | .005226 | .007344 | .004117 | .005515 |
| G-------- | .022839 | .010785 | .006319 | .002650 | .023661 | .007539 | .022431 | .008443 | .012314 |
| H-------- | .137695 | .000000 | .000060 | .000937 | .001971 | .068317 | .000000 | .000588 | .002620 |
| I-------- | .000684 | .000000 | .000697 | .000445 | .000000 | .000000 | .000808 | .000000 | .000000 |
| J-------- | .019232 | .003425 | .036031 | .007466 | .007284 | .034321 | .008732 | .015370 | .037065 |
| K-------- | .000276 | .000000 | .000000 | .000000 | .000000 | .000000 | .000000 | .000000 | .012188 |

Table 13.--Matrix of interdependent coefficients for sample data, Roger Mills County

| Sectors | Sectors |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  | A | D | E | F | G | H | I | J | K |
| A------ | 1.162831 | 0.009377 | 0.000836 | 0.001711 | 0.001871 | 0.527530 | 0.012249 | 0.000663 | 0.016578 |
| D------ | .009057 | 1.010628 | .038582 | .000251 | .000410 | .004361 | .000531 | .000514 | .000874 |
| E------ | .009520 | .000089 | 1.010476 | .000101 | .000223 | .005665 | .005588 | .002693 | .000924 |
| F------ | .104013 | .004617 | .009622 | 1.045910 | .021215 | .053405 | .009347 | .004643 | .007781 |
| G------ | .029258 | .011441 | .007353 | .002973 | 1.024429 | .021915 | .023446 | .008842 | .013570 |
| H------ | .172044 | .001417 | .000238 | .001317 | .002469 | 1.151424 | .001876 | .000762 | .005358 |
| I------ | .000849 | .000009 | .000710 | .000467 | .000011 | .000389 | 1.000825 | .000004 | .000015 |
| J------ | .030114 | .003871 | .037270 | .008040 | .007872 | .051237 | .009631 | 1.015850 | .038816 |
| K------ | .000325 | .000003 | 1/ | 1/ | 1/ | .000147 | .000003 | 1/ | 1.012343 |
| Total-- | 1.518011 | 1.041452 | 1.105087 | 1.060770 | 1.058500 | 1.816073 | 1.063496 | 1.033971 | 1.096259 |

1/ Less than 0.0000005.

Table 14.-- Matrix of primary input coefficients for sample data, Roger Mills County

| Inputs | Sectors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | D | E | F | G | H | I | J | K |
| Wages (endogenous)---- | 0.023649 | 0.020875 | 0.008533 | 0.023504 | 0.033429 | 0.032710 | 0.070629 | 0.007932 | 0.225246 |
| Wages (exogenous)----- | .023750 | .071933 | .033731 | .048281 | .051138 | .021660 | .078126 | .038715 | .067818 |
| Wages (total)--------- | .047399 | .092808 | .042264 | .071785 | .084567 | .054379 | .148755 | .046647 | .293064 |
| Imputed inputs (endogenous)-------- | .122986 | .045086 | .083842 | .035213 | .123997 | .043511 | .190627 | .094600 | .111546 |
| Imputed inputs (exogenous)--------- | .018822 | .004934 | .007551 | .006220 | .007692 | .001398 | .015307 | .008060 | .021008 |
| Imputed inputs (total)------------ | .141808 | .050020 | .091393 | .041433 | .131689 | .044909 | .205934 | .102660 | .132554 |
| Local government------ | .033833 | .009409 | .011417 | .008730 | .010385 | .001516 | .010739 | .001378 | .000196 |
| Nonlocal (production)- | .285029 | .714689 | .700496 | .675271 | .631688 | .327806 | .296009 | .146176 | .218583 |
| Nonlocal (consumption)------------- | .122961 | .097127 | .054367 | .096940 | .087967 | .032046 | .283172 | .095836 | .271719 |
| Nonlocal (total)------ | .407990 | .811816 | .754863 | .772211 | .719655 | .359852 | .579181 | .242012 | .490302 |
| Discrepancy----------- | .011676 | --- | --- | .049441 | --- | --- | --- | .575507 | --- |
| Total------------ | 0.642706 | 0.964053 | 0.899937 | 0.943600 | 0.946296 | 0.460656 | 0.944609 | 0.968204 | 0.916116 |